Nonetheless, Applicant points out that the words "substantially lead free" have a sufficiently well-defined meaning to those having ordinary skill in the pertinent art that the language is not believed to be indefinite.

Independent method claims 6 and 11 are amended to set forth process steps and to thereby overcome the § 112 rejection.

b. The § 101 Rejections

The amendments noted above to claims 6 and 11 set forth process steps so that these claims now define proper method claims.

c. The § 102 and § 103 Rejections

Claims 1-4, 6-9 and 11-16 stand rejected as either anticipated by, or obvious in view of various references. Applicant does not dispute that one of the prior art references cited by the Examiner discloses a solder having broad ranges that touch or overlap with the relatively narrower ranges of components set forth in the claims. Specifically, WO9709455 (in alloys c, f, g and h) does disclose an alloy that includes, in broad ranges, the same compounds found in the claims of the present application.

But for the reasons set forth below the claims in the subject application are allowable because the prior art fails to disclose the claimed subject matter with sufficient specificity to constitute anticipation under § 102, or to render the claims obvious under § 103. Said another way, the components of the claimed solder are limited to critical, relatively narrow ranges that are neither disclosed by, nor taught by the prior art.

It is established that where the prior art teaches broad ranges of compounds, and the claims are directed to a narrow range, and where there is evidence of unexpected results within the narrow range, then the narrow range may well be patentable if the narrow range claimed is not disclosed with "sufficient specificity" in the prior art. *See. e.g.* MPEP § 2131.03. This is a logical result: without such a rule, a broad recitation of compounds in a prior art reference would anticipate all future inventions relating to the same compounds, thereby unjustifiably precluding what may be patentable improvements.

In this case, some of alloys disclosed in the prior art cited by the Examiner teach broad ranges of the four compounds set forth in independent claims 1, 6 and

11. In some cases the ranges disclosed in the prior art are broad enough to overlap or touch the relatively narrower ranges in the claims. Table 1, below, lists the ranges of tin, silver, indium and copper found in the prior art references cited by the Examiner. The actual range percentage is shown in [brackets] in some cases:

Table 1:

Prior Art Reference		Sn % [range]	Ag % [range]	In % [range]	Cu % [range]
WO 9709455	Alloy (c)	85.6-97.6 [12]	1.5-7.0 [5.5]	0.5-6.0 [5.5]	0.4-1.4 [1]
	Alloy (f)	79.9-97.5 [17.6]	1.4-7.1 [5.7]	0.2-9.0 [8.8]	0.5-1.3 [0.8] (+Sb)
	Alloy (g)	58.0-99.6 [41.6]	0.1-10 [9.9]	0.07-20 [19.93]	0.1-3 [2.9] (+Zn)
	Alloy (h)	80.6-98.08 [17.48]	1.5-4.5 [3]	0.1-1.0 [9.9]	0.3-1.4 [1.1] (+Zn and Sb)
US 5538686		70-80	<10	3-10	<10
JP 10314980		Balance; not specified	0.5-6.0	0.5-10	0.1-3.0 (+Bi)
JP 2000141078		Balance; not specified	0.1-6	.1-50	0.0-6 (+Al)
WO 2000018536		Not specified	Not specified	Not specified	Not specified
JP 11221694		Balance; not specified	0.5-4	0-3	0-3 (+Bi)

Applicant respectfully submits that (a) these disclosures are so broad that they do not anticipate the claimed, relatively narrow ranges because they are not sufficiently specific, and (b) the prior art does not teach the claimed solder in view of the unexpected results obtained by the claimed alloys in the narrowly claimed proportions.

The ranges of Sn, Ag, In and Cu claimed in each of claims 1, 6 and 11 are as follows:

Element	Range (%)	Actual Claimed Range
Sn	4.7	88.5-93.2
Ag	1	3.5-4.5
In	4	2.0-6.0
Cu	0.7	0.3-1

These relatively narrow and specific ranges are far narrower than the ranges disclosed in the prior art, and the unexpected results to be obtained by using the claimed solders are amply shown by the test results detailed in the specification. Thus, the range of tin found in the claims is at most 1/3 as large as the nearest range disclosed in WO 9709455; the range of silver is similarly 1/3 as large; the range of indium is about 4/5 as large; and the range of copper is similar. Taken as a whole, the claimed alloy is substantially different.

As a first example, consider the results of Test 1 in the specification. In that test, the claimed solder ("Alloy 349" in Figs. 1 and 2) proved to have comparable wetting times at each temperature tested to conventional lead-containing solder. More importantly, Alloy 349 performed better than other tested solders, even lead-free compositions.

Test 2 evaluated the coefficient of thermal expansion and the specific gravity of numerous solder alloys. Again, Alloy 349--the claimed alloy--outperformed the others.

Tests 3, 4 and 5 evaluated fillet lifting, copper dissolution rate, and drossing, respectively, of the claimed solder versus various other lead-free alloys. Again, the claimed compound performed superiorly.

The results of the tests set forth in the specification represent unexpected results of result-effective variable testing that weigh against finding the claims anticipated or obvious. Stated another way, the experimental results detailed in the specification establish that the claimed ranges of the four elements are critical and that unexpectedly superior results are obtained when the four elements are combined in the narrow ranges called out in the claims. These are optimal results and considerations that cannot be derived from the prior art disclosures.

The criticality of the relatively narrow ranges found in claims 1, 6 and 11 is supported by the fact that there are several examples of alloys in the prior art that disclose broad ranges. The effectiveness of a solder having the components claimed in these narrow ranges would not have been obvious to one having ordinary skill in the art, even with an inordinate amount of experimentation.

Claims 4, 9 and 14 are even more narrowly drafted than the independent claims from which they depend: there is no range whatsoever. Claims 5, 10 and 15 add P to the claims from which they depend (claims 4, 9 and 14, respectively).

Claims 2, 7 and 12 add the limitation of the addition of an anti-oxidant or anti-skinning additive to the alloy set forth in the underlying independent claim. Claims 3 and 8 specify that the anti-oxidant or anti-skinning additive is phosphorous or another non-metallic compound or element. The Examiner rejects these claims as obvious because the claims read on zero, or alternately based on JP 2001058286, which discloses use of P in a lead-free solder. However, these claims are allowable based on dependency from an allowable base claim.

4. Conclusion

All of the claims pending in the application are believed to be in condition for allowance, and such action is requested. If any issues remain outstanding the Examiner is requested to contact the undersigned by telephone.

Respectfully submitted,

January 7, 2003

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Marked Up Amended Claims
Application No. 09/932,793

1. (Amended) A ~~substantially lead-free~~ solder comprising:

from 88.5% to 93.2% tin;

from 3.5% to 4.5% silver;

from 2.0% to 6% indium; and

from 0.3% to 1% copper.

6. (Amended) A method of preparing a ~~substantially lead-free~~ solder, comprising the steps of ~~mixing tin, silver, indium and copper such that~~:

(a) mixing tin, silver, indium and copper to form the solder such that

~~the~~ the proportion of tin in the solder is from 88.5% to 93.2%;

~~the~~ the proportion of silver in the solder is from 3.5% to 4.5%;

~~the~~ the proportion of indium in the solder is from 2.0% to 6%; and

~~the~~ the proportion of copper in the solder is from 0.3% to 1.0%.

11. (Amended) A method of soldering, comprising the steps of ~~using a substantially lead-free solder comprising~~:

(a) forming a solder by combining tin, silver, indium and copper in the following proportions:

from 88.5% to 93.2~~5~~% tin;

from 3.5% to 4.5% silver;

from 2.0% to 6.0% indium; ~~and~~

from 0.3% to 1.0% copper; and

(b) using the solder formed in step (a) to solder.